Ministry of
Transportation and
Communications

Ontario

MI-74

TENSAR GEOGRID TEST SECTION HWY 59

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

ONTARIO
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

TENSAR GEOGRID

TEST SECTION

HWY 59

By

R. F. McLuckie

P. Korgemagi

D. F. Lynch

Ministry of Transportation and Communications
Engineering Materials Office
Bituminous Section

Materials Information Report No. 74

TABLE OF CONTENTS

PAGE

1. INTRODUCTION 1

2. PURPOSE 1

3. PREVIOUS APPLICATION 1

    3.1 Problems 1

4. HWY. 59 TEST SECTION 3

    4.1 Test Location 3
    4.2 Installation Procedures 4
    4.3 Costs 14

5. DATA COLLECTION 14

6. DISCUSSION 14

7. PERFORMANCE EVALUATION AFTER 2 YEARS 15

8. CONCLUSION 17

APPENDIX 1 TECHNICAL DATA FOR TENSAR AR-4

1. INTRODUCTION

A pavement reinforcement test section using Tensar AR-1 geogrid was installed on Highway 59 (Contract 84-06) in London District. This interim report documents the installation procedure and the testing/monitoring program established to evaluate the test section.

2. PURPOSE

The primary purpose of installing the test section was to:

(1) Demonstrate the ability to place Tensar on a existing asphalt roadway and overlay with hot mix. Previously problems had been encountered with the installation procedure.

(2) Determine whether the Tensar aids in reducing crack reflection in an overlay.

In addition, the Tensar geogrid has been proposed as a structural enhancer for the pavement. The Tensar performance in this regard is to be assessed.

3. PREVIOUS APPLICATION

An initial trial section using Tensar had been installed on Highway 5 west of Guelph Line (Contract 81-20) in Hamilton District[1]. The design involved widening from two to four lanes. The widened portion consists of a layer of 40 mm surface course, three 40 mm binder courses of HL6, 150 mm of Granular A and 300 mm of granular subbase.

The Tensar was placed between the lower and middle binders. The installation procedures provided that four rolls of Tensar, each 2 m wide, be placed and overlapped to cover the 7.3 m (24') widening. One end of Tensar was fastened to the lower binder with concrete nails and washers placed 150 mm apart. The mesh was tensioned by pulling an iron bar (threaded through the free end of the mesh) with chains attached to the back hitch of a pick-up truck. Tension in the central area was quite high, but the outside edges were loose (not under tension). The tensioned end of the roll was then nailed down and the bar was removed.

3.1 Problems

1) Originally Tensar was produced in 3 m x 50 m rolls. Preliminary testing indicated that the Tensar would not lie flat because of the production process. The outer edges of the rolls were stretched slightly longer than the central portion. To make the material lie flat the outside edges of the

rolls were cut off to make the total width 2 m. Even then the central portion had to be stretched to make the edges lie flat.

2) Attempts were made to join the two 50 m long rolls with plastic ties to provide sufficient length to cover the test section. The plastic ties failed when the Tensar was tensioned. Subsequently each roll had to be nailed at the ends.

3) The nails holding the ends of the mesh were inadequate to hold the tension applied. Many were pulled 25 mm or so through the mix or were pulled out. At some locations a tension crack developed in the mix over and along the nails for a distance of a metre or so.

4) There were several major problems when the test section was overlaid with the next lift of hot mix.

(i) During paving, the edges of the mesh beyond the paver treads tended to rise up about 150 mm in a bow wave, particularly inside the edge nearest centreline. The bow wave occurred in front of the paver screw and was pushed back down as the hot mix was placed on top. Behind the screed the hot mix surface exhibited a series of short fine cracks at a 45° angle to the direction of travel. These cracks were "spongy" even after final rolling.

(ii) Over the longitudinal overlap a furrow appeared in the surface of the middle binder course. The furrow, 75 mm wide and about 25 mm deep, started to appear about one minute after the paver passed and was fully developed within three minutes. Possibly this was due to theshrinkage of the Tensar in the unrestrained transverse direction.

This shrinkage was particularly bad at the joint between the new lanes. After the first pass the edge of the mesh in the driving lane was partially covered. When the driving lane was paved the adjacent cooled mix was pulled apart by as much as 25 mm at several locations. Subsequent rolling had no healing effect and these areas remained spongy.

(iii) At one spot while paving on a downgrade the mesh broke and had to be guided back under the paver. Possibly the truck brakes had been applied locking the wheels while the paver was in forward motion.

(iv) The riding quality of the finished middle binder was poor. In addition to the furrows, undulations in the mat were created by the mesh folding at the edges and rising high enough to affect the automatic screed controls. The upper binder course was able to correct most of the problems encountered.

4. HWY. 59 TEST SECTION

In the spring of 1984, the Tensar Corporation approached MTC for another Tensar test section. They claimed that the placement problems previously identified had been addressed. A test section was arranged for Contract 84-06 on Hwy 59.

The demonstration provided for a 100 m section of the Tensar AR-1 mesh. The mesh would be held flat with an application of emulsion and chips. Two 100 m control sections were established, one with emulsion and chips, and the other with no treatment. The control sections and the demonstration section were to be overlaid with 50 mm of RHM. This depth of hot mix had been increased from the design depth of 40 mm at the request of the Tensar Corporation. They felt that the increased depth would dramatically improve the retardation of crack reflection in the overlay.

4.1 Test Location

The test and control sections were located on Hwy. 59 just south of Regional Road 45. The following station to station limits identify the sections:

STA to STA	
12+410 to 12+510 NBL	50 mm Overlay
12+510 to 12+610 NBL	50 mm overlay with emulsion
12+510 to 12+620 SBL	and chips
12+610 to 12+710 NBL	50 mm overlay with Tensar geogrid
12+620 to 12+720 SBL	with emulsion and chips.

Originally it had been intended to install the Tensar demonstration section from Sta. 12+225 to 12+325. This location had been chosen and agreed upon by Tensar staff, Regional Construction staff and Head Office Bituminous Section. The location offered a variety of cracks and would have provided a very good test of the product. The day prior to the installation of the test section, Tensar personnel unilaterally relocated the test section.

4.2 Installation Procedure

The geogrid used was Tensar AR-1 (See Appendix 1 for technical data). The mesh was custom cut at the plant to 3.5 m which corresponds to the final pavement width (2 x 3.5 m). The existing pavement was 6.8 m wide and the Tensar extended onto both shoulders. The 50 m rolls of Tensar were spliced with metal hog-rings to the required length of 100 m (Figure 1). One section of Tensar was placed on each lane. There was a 10 m stagger in the adjacent lane section (i.e. the mesh in the southbound lane was placed 10 m further north than the northbound lane).

The Tensar was placed on the northbound lane first. The south end of the mesh was fastened by a metal strap that was nailed to the existing pavement. The nails were driven by a compressed air nailing gun (Figures 2 & 3). Spikes 300 mm in length were driven into the granular shoulder to hold down the outer edge of the Tensar. The Tensar was rolled out by hand (Figures 4 & 5). To make the geogrid lie flat, tensioning of the mesh was carried out by attaching a steel "stretcher" or fastening bar to the free end. The metal stretcher, similar in principal to that used for stretching farm fence, had three pull points in the horizontal plane (shoulder, midlane and centreline) where chains were attached (Figure 6). The chains were fixed to a dynamometer which was hooked to a hand winch (Figure 7). The winch was anchored to an iron pipe placed behind the front tires of a panel truck (Figure 8). Another metal strap was threaded about 1 m inside the steel stretcher. Tension was applied via the hand winch (Figure 9). The dynamometer measured the tension applied and assured that the Tensar was not overstressed. Final determination of tension was based on how flat the geogrid appeared. After proper tensioning, the metal strap was nailed and the mesh cut to remove the stretcher.

The section was then sprayed with RS-2 emulsion followed by an application of 3/8 inch chips with subsequent rolling (Figures 10 & 11). The application of emulsion and chips was undertaken by the Region of Haldimand and Norfolk.

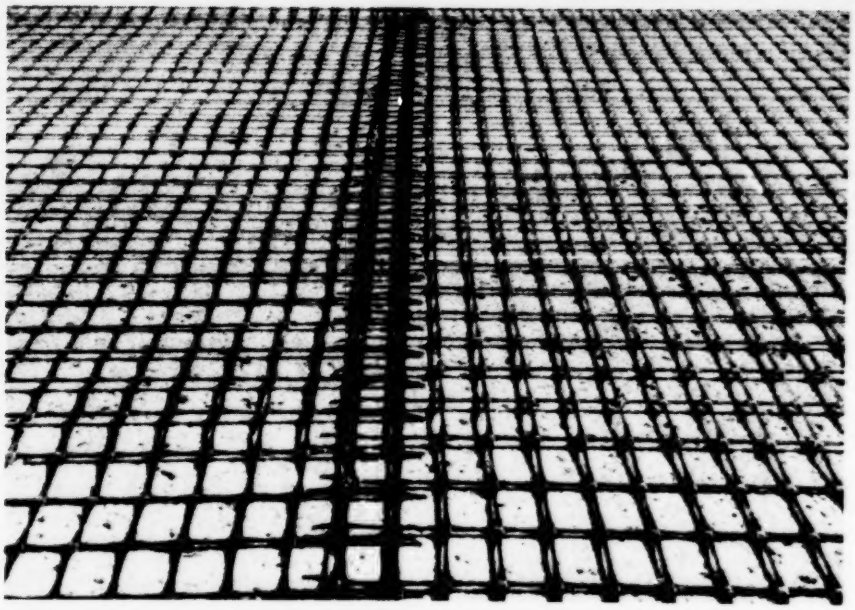


FIGURE 1: FACTORY SPLICE IN TENSAR

FIGURE 2: NAILS BEING DRIVEN INTO METAL STRAP WITH COMPRESSED AIR GUN.

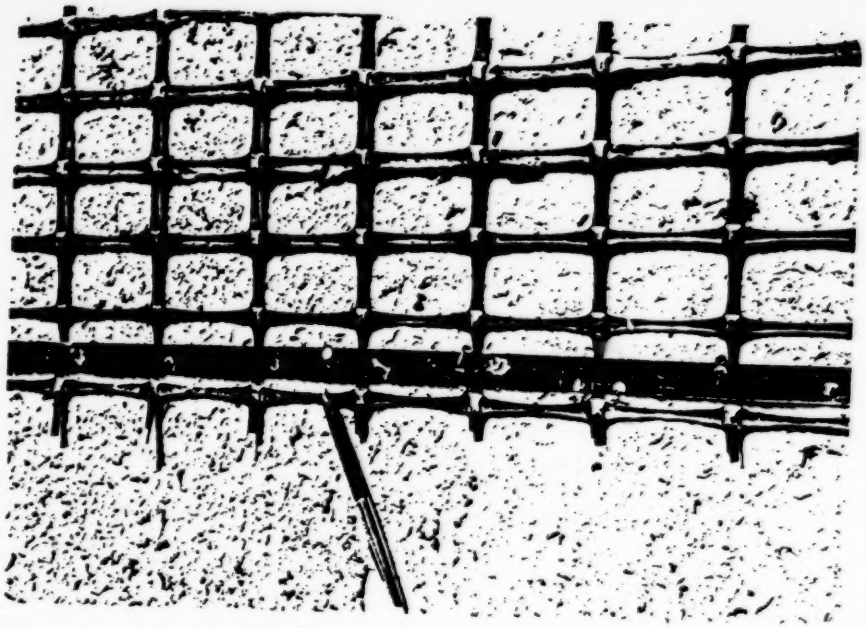


FIGURE 3: NAILS DRIVEN INTO METAL STRAP AT END OF MESH (NOTE LITTLE ENDS OF MESH WERE SUBSEQUENTLY NIPPED OFF)

FIGURE 4: ROLL OUT APPLICATION OF TENSAR

FIGURE 5: ROLL OUT APPLICATION OF TENSAR (NOTE TENSAR EXTENDS ONTO SHOULDER TO MATCH NEW PAVEMENT WIDTH).

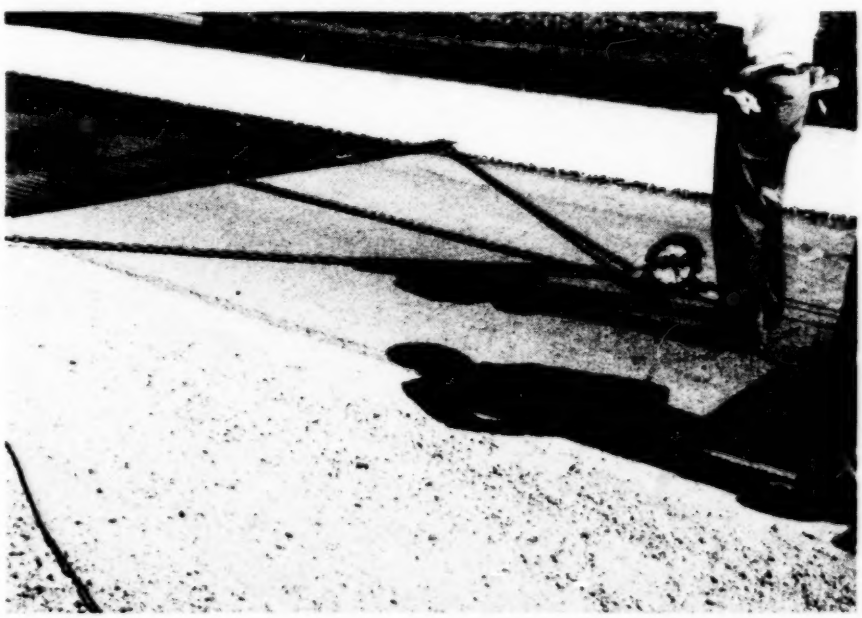


FIGURE 6: STEEL STRETCHER WITH THREE PULL POINTS IN HORIZONTAL PLANE

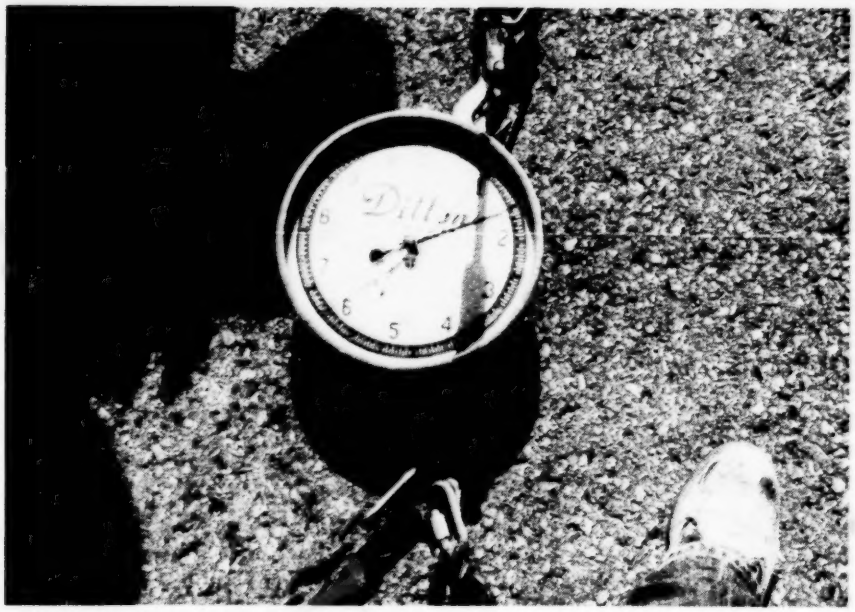


FIGURE 7: DYNAMOMETER

FIGURE 8: TENSIONING SYSTEM ANCHORED TO IRON PIPE BEHIND FRONT TIRES OF PANEL TRUCK (NOTE THREADED STEEL STRAP AT END OF TENSAR)

FIGURE 9: HAND WINCH BEING USED TO APPLY TENSION TO TENSAR

FIGURE 10: APPLICATION OF RS-2 EMULSION

The northbound lane in the test section area was covered with Tensar mesh from Sta. 12+510 to 12+610 with a tension of 3.6 kN being applied at the north end. The southbound lane was covered with Tensar from Sta. 12+620 to 12+520 with a tension of 4.5 kN applied at the south end.

During the installation on the northbound lane, the emulsion was sprayed prior to the tensioning of the mesh. It took approximately ten minutes to tension and fasten the free end prior to chip application. The southbound lane was installed as described (Figure 12). Application rates are detailed in Table 1.

Traffic was reduced to one lane during the application of the mesh and kept at reduced speeds for one and a half hours after completion of the test section. Three hours after the completion of the test section, the chip seal was swept to remove loose stone. Some areas where the mesh was exposed, particularly at the edge of old pavement, were resprayed with emulsion by hand and recovered with aggregate (Figure 13). Exposed mesh along the edge of old pavement was caused by shoulder drop off. The shoulders were not graded prior to installation of the mesh.

Two days after the installation a significant amount of aggregate loss occurred exposing the mesh. A 1 m strip of mesh was exposed in the northbound wheel track.

On September 12, the test section was swept to remove loose stone and a second application of chips and seal was undertaken. The emulsion rate was 1.9 L/m^2. A finer aggregate (6 mm Hagerville Stone) was used at a rate of 10.9 kg/m^2. The control section did not receive the second application because there was little aggregate loss in that area.

The test and control sections were overlaid with recycled hot mix on September 29, 1984. Prior to overlaying, the test section was inspected. There were several small amounts of mesh exposed (Figures 14 & 15). These areas generally included splices at roll ends and along centreline. The balance of the area exhibited a slight corrugation induced by the mesh. No cracks in the surface treatment were visible[2].

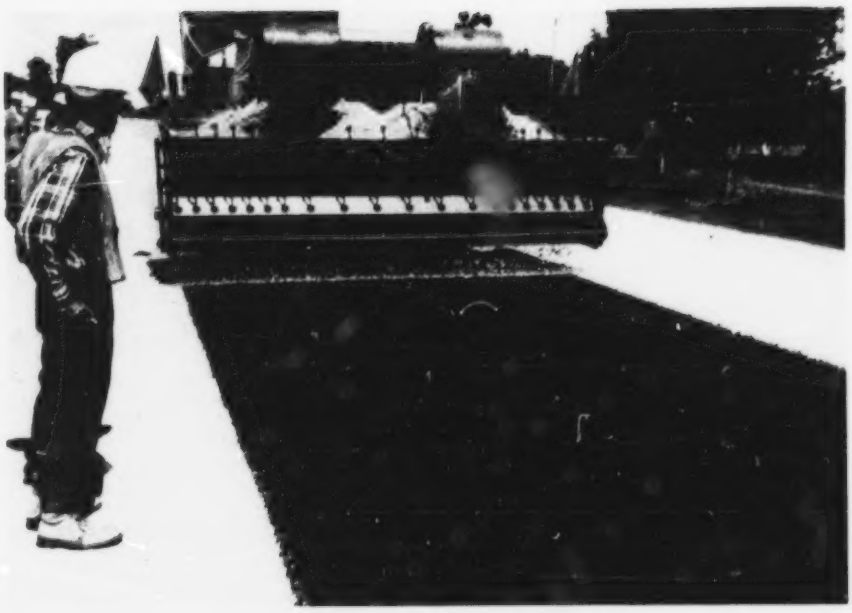


FIGURE 11: APPLICATION OF CHIPS

TABLE 1: APPLICATION RATES

	NBL	SBL
EMULSION	1.9 L/m^2	2.2 L/m^2
CHIPS	10.9 kg/m^2	10.9 kg/m^2

FIGURE 12: COMPLETED TEST SECTION

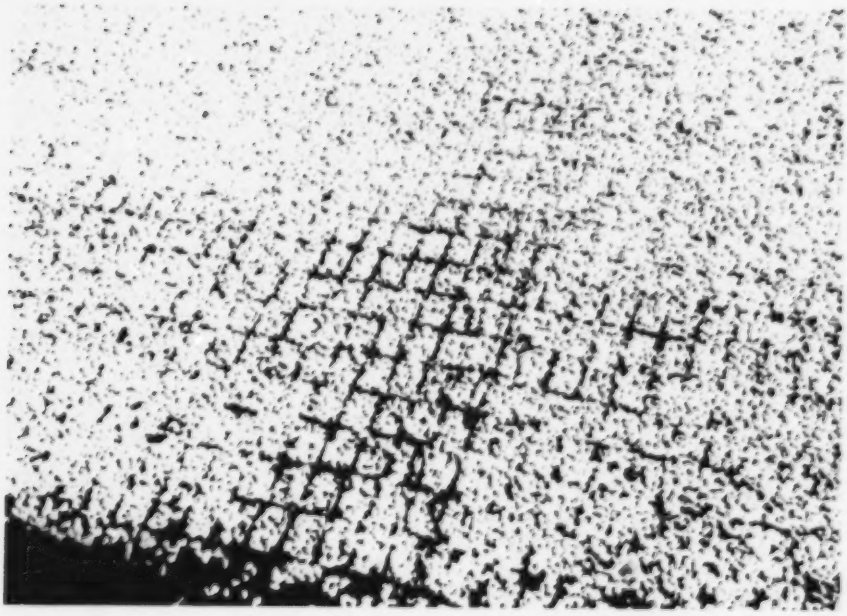


FIGURE 13: EXPOSED MESH AT SPLICE

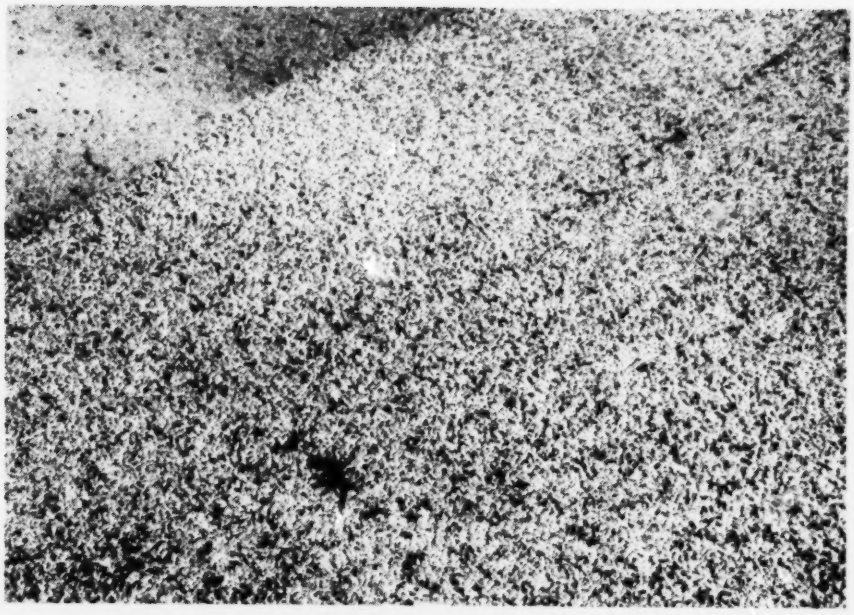


FIGURE 14: METAL STRAP SHOWING THROUGH CHIP SEAL

FIGURE 15: SMALL AMOUNTS OF MESH EXPOSED

Prior to placing of hot mix, the surface treatment areas were swept clean with a power broom within an hour of paving. A light tack coat of SS-1 emulsion (diluted) was applied to the surface of the entire job by a distributor truck about two minutes prior to paving. The RHM was placed 50 mm thick (after compaction) at a mix temperature between 125° and 130°C. Paving over the trial area and the control sections posed no problems.

4.3 Costs

The costs associated with the test and control sections were borne by the Tensar Corporation. The costs included installation of the Tensar, application of emulsion and chips and costs associated with increasing the hot mix overlay depth from 40 mm to 50 mm. The preliminary estimates were:

Tensar	\$2.00 m^2
Tensar installation	\$0.25 m^2
Chip Seal	\$0.90 m^2
	\$3.15 m^2

5. DATA COLLECTION

Crack mapping of the demonstration and control sections was undertaken by the Tensar Corporation and is included in their report "Tensar Reinforced Pavement Trial on Hwy. 59 Ontario" November 1984[3]. Follow up crack mappings was undertaken in the spring of 1985.

A request was made to the Design Evaluation and Pavement Section of the Highway Design Office to include this test section on the 1985 Dynaflect testing circuit.

6. DISCUSSION

It is readily apparent that the problems identified in the original test section have been addressed. These include:

(i) Improved production process so the grid does not warp but lays flat.

(ii) The splicing technique using hog rings is sufficient to withstand the applied tensions.

(iii) The use of a metal strap with nails to hold the ends was sufficient to resist the applied tension without damaging the underlying pavement.

(iv) There were none of the previous problems involved with paving over the geogrid. The geogrid remained flat and was held well to the old pavement surface.

The major problem on test section was the loss of aggregate from the first application on the Tensar test section. This may be partially due to the late application of aggregate. It also could be caused by insufficient emulsion application rate for the combined effect of the chip size and Tensar. The application rates (1.9 L/m^2 NBL and 2.2 L/m^2 SBL) were sufficient for the control area because there was little aggregate loss. However, given that the aggregate was lying on top of the Tensar (which has 2 mm thick mesh) there was insufficient depth of emulsion to hold it in place. It should be noted that the designated 9.5 mm (3/8 inch) aggregate had in fact 53% retained on the 9.5 mm (3/8 inch) sieve[3].

The Tensar extended over onto the granular shoulder to conform to the new pavement width. The shoulder was not graded prior to placing the Tensar. The shoulder drop off made the Tensar stand proud in this area and required respraying with emulsion by hand. Consideration should be given to grading shoulder areas prior to placement of the Tensar.

7. PERFORMANCE AND EVALUATION AFTER 2 YEARS

On 86-03-26, a review of the Tensar Test Sections on Hwy 59 (Cont. 84-06) was undertaken. This represents a review after two winters of service.

Tensar Section - SBL 12+720 to 12+620
NBL 12+710 to 12+610

SBL section - very slight transverse crack at north end over metal strap trying Tensar down.

- no distress in SBL section.

- NBL section.

  - intermittent slight edge cracking about 150 mm inside E.P. from Sta. 12+610 to 12+660.

  - frequent multiple edge cracking (mostly slight with some slight to medium) up to 300 mm inside E.P. from Sta. 12+660 to 12+710.

Chip Seal Control - SBL 12+510 to 12+620
NBL 12+510 to 12+610

- no distress in SBL section.

- NBL has small 2 m very slight edge crack about 150 mm inside E.P. (Sta. 12+530).

Control - 12+410 to 12+510

- no distress in SBL section.

- NBL has slight to moderate edge crack 150 mm inside E.P. from Sta. 12+480 to Sta. 12+510.

Note: From Reg. Rd. 45 northerly to Langton the NBL is experiencing pavement edge cracking (possibly due to shoulder heaving in core constructed areas).

Observations

Tensar test section has more (pavement edge) cracking than either control section in NBL.

Conclusions

Tensar does not appear to provide reinforcement against pavement edge cracking.

Detailed crack mapping is not required at this time.

There is no significant difference between test section and either control section after two winters of service.

8. CONCLUSIONS

1) The Tensar Corporation has demonstrated that the Tensar geogrid can be effectively placed on pavement using a surface treatment. The geogrid and surface treatment can be left open to traffic and then covered with a hot mix overlay with no problems.

2) It is premature to comment on the crack retarding and structural enhancing properties of the Tensar. Monitoring of crack reflection should continue for a period not less than two winters.

References

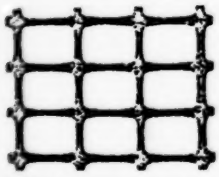
1) Phang W.A. "MTC/GULF - TENSAR GEOGRID PAVING TRIAL NOV. 81" Pavement Research, Research and Development Branch, Ontario Ministry of Transportation and Communications, Nov. 1981.

2) Evers R.C. "Paving over Tensar Hwy. 59 Trial" Memorandum to Author, Bituminous Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, 84 09 27.

3) Crawford W.W. "Tensar Reinforced Pavement Trial on Hwy. 59, Ontario" Construction Report for Gulf Canada Ltd., Research and Development Department, Sheridan Park, Ontario. Task No. 384-84-66, Nov. 1984.

Appendix 1

Technical Data for Tensar AR-1



Tensar

The Tensar Corporation

c/o Gulf Canada Research Cent
2489 North Sheridan Way
Mississauga, Ontario
L5K 1A8
(416) 823-5200
Telex: 06-982446
In Atlanta:
Tel: (404) 968-3255

Tensar* ARI Geogrid Provisional Data

Application

Tensar* geogrid has been developed for asphalt pavement reinforcement. The biaxial open mesh structure provides for bond and interlock with the aggregate.

Structural Characteristics	ARI
Width (ft)	9.8
Weight (lb/sq. yard)	0.4
Mesh opening (inch)	2.8 x 2.2.
Colour	Black

Mechanical Characteristics**

Tensile strength - max load (lb/ft)	1100 (1870)
Extension at max load (%)	19.4 (12.9)
Extension at 40% load (%)	4.0 (4.0)
Thermal Stability	Suitable for use up to 300°F

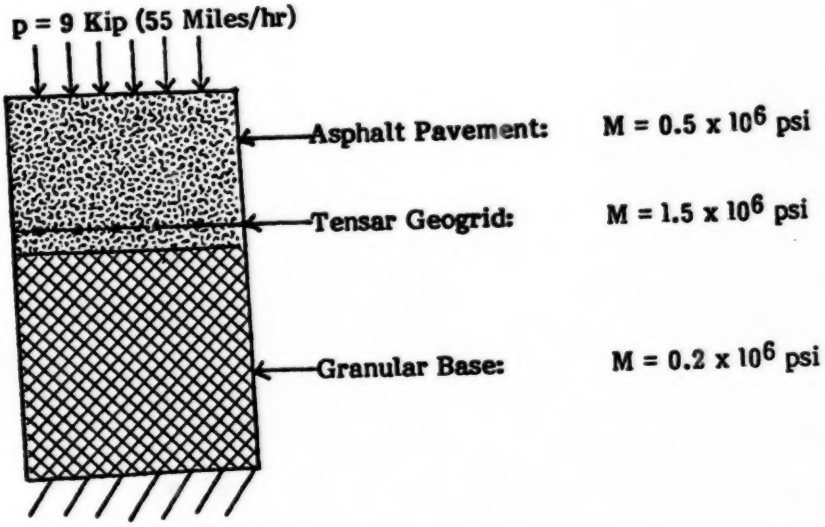
Polymer Characteristics - ARI

Raw Material		: Polypropylene
Shore Hardness D	(Din 53505)	: 74
Vicat Softening Point	(Din 53460) (°C)	: 148
Impact Strength	(Din 53453) (kJ/m^2)	: 4.5
Abrasion Resistance	(Din 53754E) (mm^3/100 revs)	: 14
Chemical Resistance		: Resistance to all natural occuring alkaline & acidic soil conditions
Biological Resistance		: Resistance to attack by bacteria, fungi & vermin
Sunlight Resistance		: Resistant to UV attack

* Trademark
** Figures in brackets are for characteristics across roll width

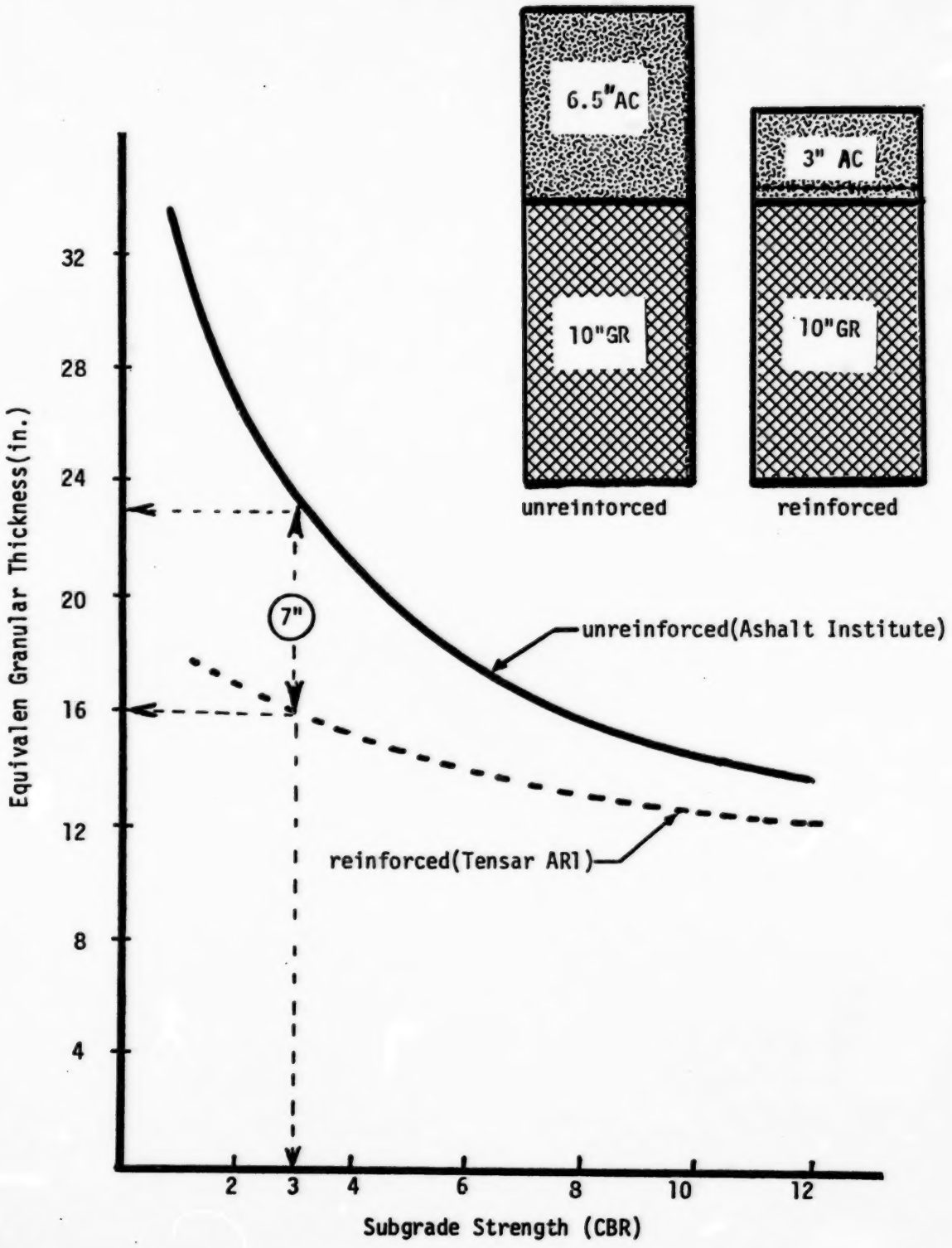
CHARACTERISTICS OF REINFORCEMENT MATERIALS FOR ASPHALT PAVEMENTS

	Steel	Polypropylene	Tensar
Tensile Strength:			
(psi)	50,000	5,000	30,000
(MPa)	345	35	200
Elastic Modulus:			
(psi x 10^6)	30	0.2	1.5
(GPa)	200	1.4	10

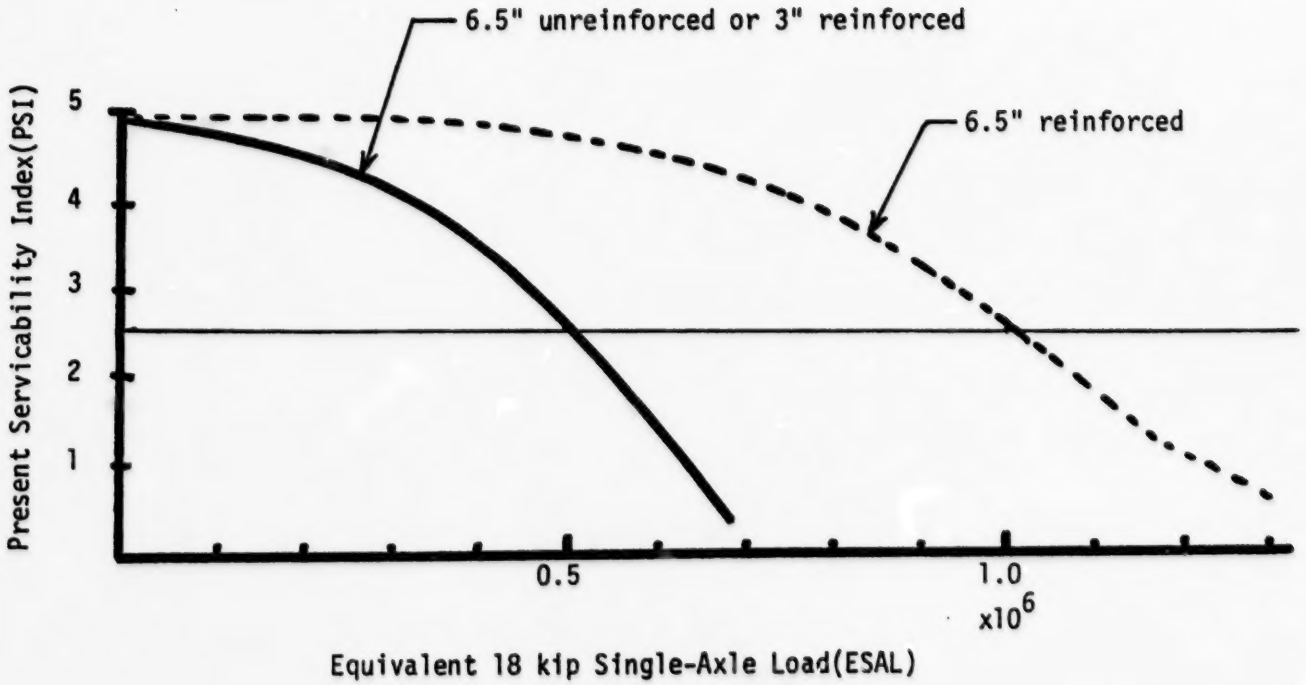


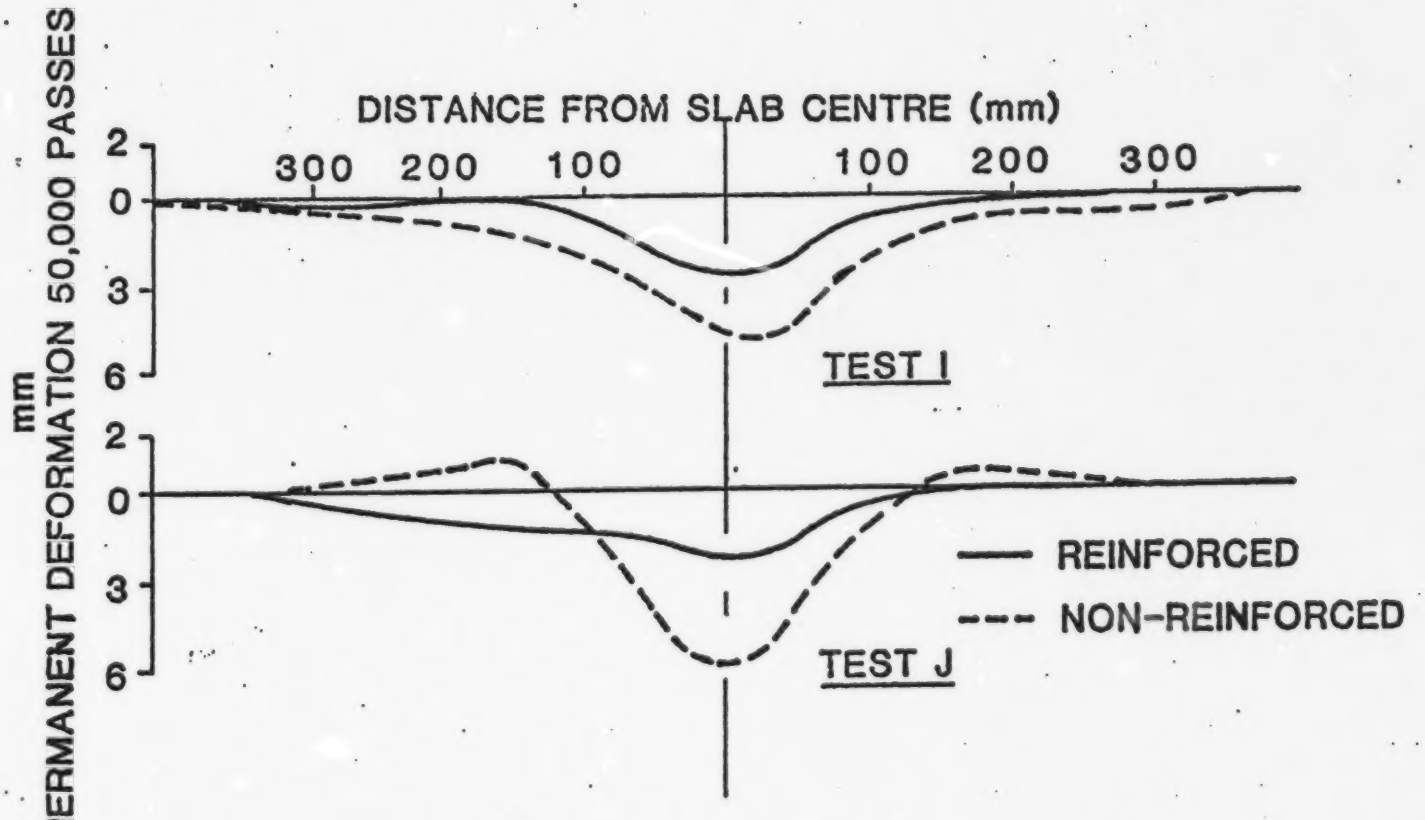
EQUIVALENT THICKNESS

(for N= 500,000 ESAL's)



EXAMPLE: INCREASED SERVICE LIFE





TRANSVERSE DEFORMATION PROFILES AFTER 50,000 LOAD APPLICATIONS

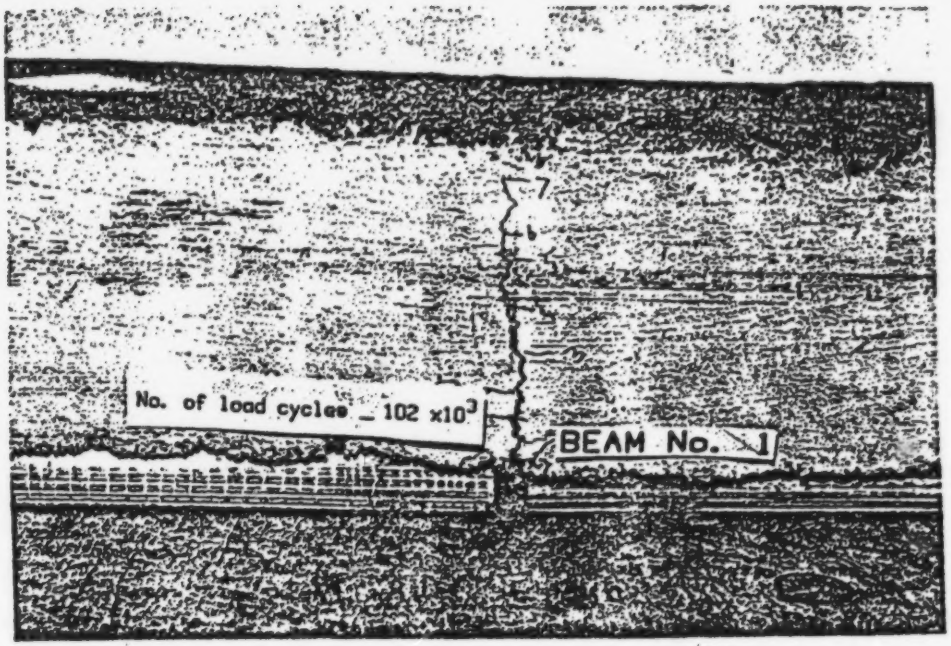


Fig.4.13 UNREINFORCED BEAM

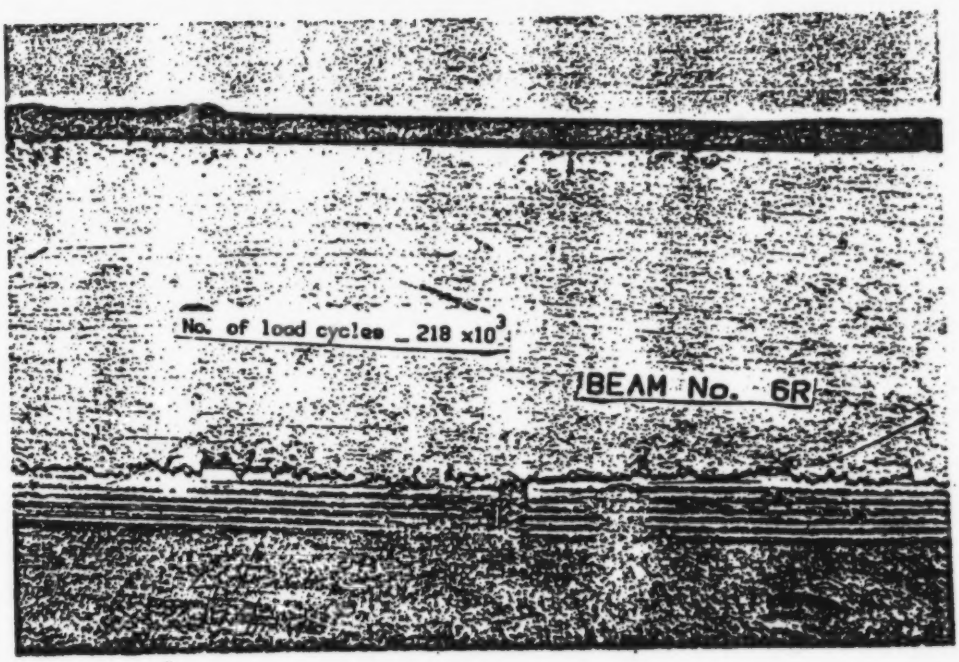
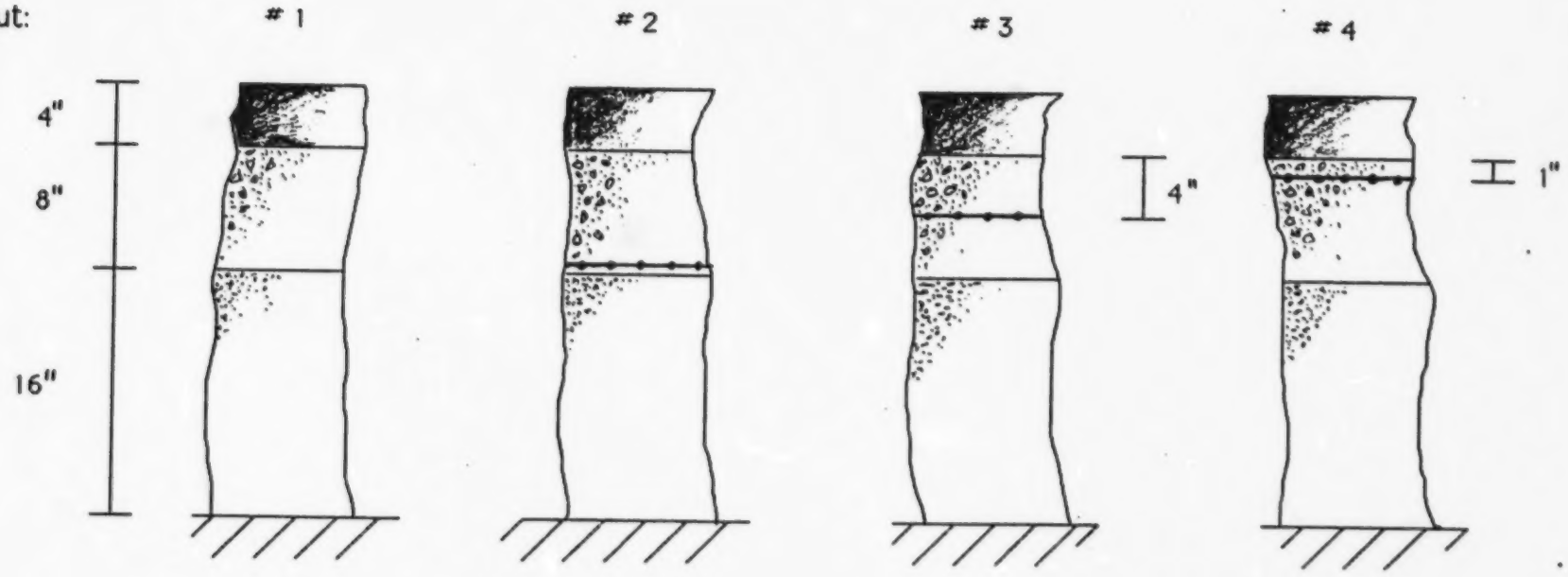


Fig.4.14 BEAM WITH REINFORCEMENT AT BOTTOM OF ASPHALT LAYER

GRANULAR BASE REINFORCEMENT: Test Loop 1

Test Lay out:



	#1	#2	#3	#4
No. of Load cycles at 0.4" deformation	60,000	150,000	250,000	40,000
Dynamic deflection (inch) at 100,000 Load cycles	0.058	0.045